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ROYAL AIRCRAFT ESTABLISHMENT

Farnborough, Hants.

TESTS ON A FLUORIDE FLUX FOR WELDING MAGNESIUM ALLOYS

by

H. BROOKS, B.Sc., A.I.M.

and

F/LT. L. RAKOWSKI, Inz.Chem.(Warsaw)

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SUMMARY

Tests were made to determine the suitability of a flux for use in welding magnesium-base alloys by the oxyacetylene process. The flux consisted of a mixture of fluorides of lithium, magnesium, calcium and barium. Butt welds were made between pairs of 10G sheet or strip samples to specifications D.T.D.118, D.T.D.120A and D.T.D.259. The flux was not satisfactory for welding the magnesium-aluminium-zinc alloys to D.T.D.120A and D.T.D.259 but good welds could be made with it in the magnesium-manganese alloy to D.T.D.118. The flux residues caused practically no corrosion when uncleaned joints were exposed to a simulated inland tropical cycle, and joints cleaned by scrubbing and subsequently chromate treated showed no corrosion at all after exposure to these conditions for 28 days.

Introduction

The sample of flux which has been tested was brought from Germany by a B.I.O.S. investigating team who found that it had been used at I.G. Farbenindustrie Bitterfeld for oxyacetylene welding the magnesium-aluminium-zinc alloys, AZM and AZ 855. The flux, known as Elektronfluss IV, was stated to be non-corrosive and non-hygroscopic and to have the following composition:-

Lithium fluoride	22%
Magnesium fluoride	27%
Calcium fluoride	18%
Barium fluoride	33%

Welding tests were made with the flux and some of the joints were stored in a humid atmosphere and examined at intervals to ascertain whether the flux residues had any corrosive action.

Welding tests

These were first made on 10G magnesium-aluminium-zinc alloy sheet and extruded strip supplied to specifications D.T.D.120A and 259 respectively and originally it was not intended to carry out tests on the magnesium-manganese alloy to D.T.D.118 since the flux was understood to be unsuitable for this alloy. Butt welds were made between pairs of 4" × 2" samples, strips cut from the parent metal being used as filler material. The flux was mixed with water to form a paste which was brushed on to the filler strip and the top and bottom edges of the joint. Because of the poor action of the flux welding was very difficult on both materials, and although several methods of joint preparation including bevelling were tried, satisfactory penetration could not be obtained. The ineffectiveness of the flux was believed to be partially attributable to its high melting point (stated to be 610°C) so that when welding the magnesium-aluminium-zinc alloys the flux is not completely melted and cannot therefore work efficiently. Since the melting point of the magnesium-manganese alloy is higher than that of the flux it seemed likely that the flux might actually work better on this alloy than on the magnesium-aluminium-zinc alloys which melt at lower temperatures. A few test joints were therefore made in sheet to specification D.T.D.118 and it was found that the flux worked quite well on this material.

Corrosion tests

Welds in materials to specifications D.T.D.120A and 259 were stored in the laboratory for 6 days and were then exposed to a simulated inland tropical cycle of humidity and temperature for 28 days together with similar welds made with a standard flux A which contains chlorides. Some of the specimens were exposed with the flux residues left untouched on the welds, others were scrubbed in water with a steel brush and then chromated in bath IV of D.T.D.911 before exposure but even this treatment did not completely remove the residues of the fluoride flux. The appearance of typical specimens at the end of these exposure tests is shown in the photographs (Figs.1 and 2) and observations made during the tests are given in Table I. No corrosion tests have been made on welds in D.T.D.118 material since these welds were not made until after the main tests were completed. However it is reasonable to suppose that the flux residues would be no more corrosive to this alloy than to those which have been tested.

Conclusions

The flux is considered unsuitable for welding magnesium-aluminium-zinc alloy sheet and strip in the thicknesses common in aircraft construction but it may be suitable for welding thicker gauges of this type of alloy on which manipulation of the welding rod might be used to assist in breaking up the oxide films. However the flux is suitable for welding thin gauge magnesium-manganese alloy sheet. Where it can be used, the flux possesses the valuable advantage of being practically non-corrosive.

Attached:

Table I
Figs. 1 and 2 (Photographs)

Circulation:

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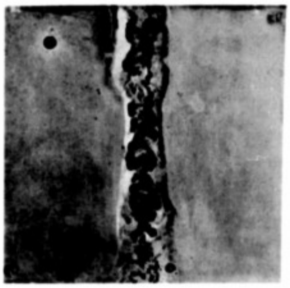
TABLE I. Humid atmosphere test on fluxes for magnesium alloys

Oxyacetylene butt welds, between pieces of 10G sheet or strip, prepared and treated as described below were exposed for 28 days to a 13 day simulated tropical cycle of humidity and temperature: First day: 140°F for 24 hours, relative humidity about 80%. Each of next twelve days: 90°F and 95% R.H. for 8 hours; 80°F and saturation for 16 hours, with condensation on the specimens.

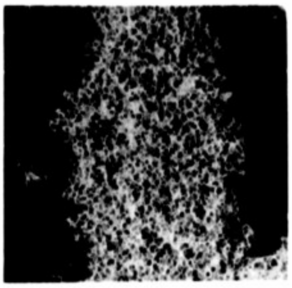
Specimen Nos.	Material Specification	Flux used in welding	Treatment applied after welding	Appearance after storage in laboratory for 6 days before exposure	Observations after exposure for the following periods	
					11 days	28 days
2	D.T.D.120A	Elektronfluss IV	None	Unchanged; welds covered with flux residues.	Spots of corrosion all over except on upper side of weld.	Spots of corrosion all over; considerable corrosion on underside of weld (this specimen was probably contaminated with chloride flux).
3	D.T.D.120A	Elektronfluss IV	None	As Specimen 2.	Practically no corrosion on the weld; some spots of corrosion elsewhere.	Spots of corrosion all over.
4 and 5	D.T.D.120A	Elektronfluss IV	Scrubbed in water with steel brush and chromated in bath IV of D.T.D.911.	Unchanged golden-grey film; some hard fused flux residues still left on welds.	Unchanged	Unchanged
6	D.T.D.259	Elektronfluss IV	None	As specimens 2 and 3.	No corrosion on the weld; some corrosion elsewhere.	Spots of corrosion all over.
7	D.T.D.259	Elektronfluss IV	Scrubbed in water with steel brush and chromated in bath IV of D.T.D.911.	As specimens 2 and 3.	Unchanged	Unchanged
8	D.T.D.120A	Standard flux A containing chlorides	None	Very considerable corrosion on and near the weld.	Considerably more corrosion.	Extremely severe corrosion on and near the weld.
1	D.T.D.120A	Standard flux A containing chlorides	Scrubbed in water with steel brush and chromated in bath IV of D.T.D.911.	A few spots of corrosion on the weld.	Corrosion on weld increased.	Considerable corrosion on the weld.

SPEC. 3.
EXPOSED "AS WELDED"



SPEC. 4.
EXPOSED AFTER SCRUBBING, WASHING AND CHROMATING IN BATH IV OF D.T.D. 911.

WELDED WITH NON-CORROSIVE FLUORIDE FLUX.



SPEC. 8.

SPEC.1.

WELDED WITH STANDARD FLUX A CONTAINING CHLORIDES.

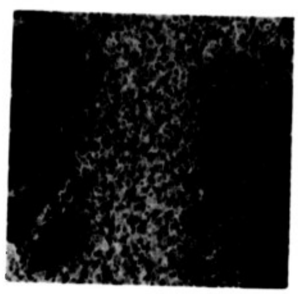
APPEARANCE OF UPPER SIDE OF WELDED D.T.D.120 / 10 S.W.G. SPECIMENS AFTER EXPOSURE TO HUMID ATMOSPHERE FOR 4 WEEKS

HUMID ATMOSPHERE TEST ON FLUXES FOR MG-ALLOYS

SPEC. 3.
EXPOSED "AS WELDED"

SPEC. 4.
EXPOSED AFTER SCRUBBING, WASHING AND CHROMATING IN BATH IV OF D.T.D. 911.

WELDED WITH NON-CORROSIVE FLUORIDE FLUX.



SPEC. 8.

SPEC.1.

WELDED WITH STANDARD FLUX A CONTAINING CHLORIDES.

APPEARANCE OF UNDER SIDE OF WELDED D.T.D.120 / 10 S.W.G. SPECIMENS AFTER EXPOSURE TO HUMID ATMOSPHERE FOR 4 WEEKS

HUMID ATMOSPHERE TEST ON FLUXES FOR MG-ALLOYS

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